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HIGH-PRESSURE PUMP FOR A FUEL INJECTION SYSTEM OF AN INTERNAL COMBUSTION ENGINE

[0001] Prior Art

[0002] The invention is based on a high-pressure pump for a fuel injection system of an internal combustion engine as generically defined by the preamble to claim 1.

[0003] One such high-pressure pump is known from German Patent Disclosure DE 198 48 035 A1. This high-pressure pump has a housing, located in which is at least one pump element which has a pump piston that is driven in a reciprocating motion, via a transmission element in the form of a polygonal ring, by a drive shaft rotatably supported in the housing. The drive shaft has an eccentric portion, on which the transmission element is rotatably supported via a bearing bush. The drive shaft is supported in the housing via two bearing points, each with one bearing bush. Lubrication of the bearing point of the transmission element on the eccentric portion of the drive shaft and of the bearing points of the drive shaft in the housing is effected by means of the fuel present in the interior of the housing. If fuel is pumped at very high pressure by the high-pressure pump, correspondingly heavy loads are put particularly on the bearing point of the transmission element and on the bearing points of the drive shaft, so that lubrication by the fuel present in the interior of the housing is no longer sufficient, and the bearing points exhibit heavy wear.

[0004] Advantages of the Invention

[0005] The high-pressure pump according to the invention as defined by the characteristics of claim 1 has the advantage over the prior art that the lubrication of at least the bearing point of the transmission element on the eccentric portion of the drive shaft is improved, at the cost

of only little structural complexity, so that fuel can be pumped at very high pressure by the high-pressure pump with little wear to the bearing point.

[0006] In the dependent claims, advantageous refinements and features of the high-pressure pump of the invention are disclosed. By means of the embodiment according to claim 3, the lubrication of the at least one bearing point of the drive shaft is also improved. The embodiment in accordance with claims 4 and 5 makes a further-improved lubrication of the bearing point possible by means of improved distribution of the fuel at the bearing point. The embodiment in accordance with claim 6 makes simple manufacture of the conduit system in the drive shaft possible. The embodiment in accordance with claims 7 and 8 makes it simple to deliver fuel into the conduit system of the drive shaft, through a bearing point of the drive shaft.

[0007] Drawing

[0008] One exemplary embodiment of the invention shown in the drawing and explained in further detail in the ensuing description. Fig. 1 shows a fuel injection system of an internal combustion engine having a high-pressure pump; Fig. 2 shows the high-pressure pump in a longitudinal section on a larger scale; Fig. 3 shows a detail, marked III in Fig. 2, with a bearing point of the high-pressure pump on a larger scale; and Fig. 4 shows a detail, marked IV in Fig. 2, with a bearing point of the high-pressure pump on a larger scale.

[0009] Description of the Exemplary Embodiment

[0010] In Fig. 1, a fuel injection system is shown for an internal combustion engine that is a self-igniting internal combustion engine. The fuel injection system has a high-pressure pump 100, by which fuel is pumped into a reservoir 110 at high pressure of up to 2000 bar. From the reservoir 110, lines 120 lead to injectors 130, located at the engine cylinders, through

which injectors fuel is injected into the combustion chamber of the cylinders. By means of a feed pump 140, fuel is pumped from a tank 150 to the intake side of the high-pressure pump 100. By means of the feed pump 140, a pressure of for instance approximately 2 to 10 bar is generated. Between the feed pump 140 and the high-pressure pump 100, a fuel metering device 160 may be located, by which the inflow of fuel from the feed pump 140 to the high-pressure pump 100 can be variably adjusted. A lubrication connection 170 branches off from the communication between the feed pump 140 and the high-pressure pump 100 toward a drive region of the high-pressure pump 100; both the high-pressure pump 100 and its drive region will be described in further detail hereinafter. A pressure valve 180 is located in the lubrication connection 170 and opens the lubrication connection 170 only when a predetermined pressure is exceeded. The flow through the lubrication connection 170 is preferably limited by a throttle restriction 190.

[0011] In Fig. 2, the high-pressure pump 100 is shown enlarged. The high-pressure pump has a housing 10, which is embodied in multiple parts and in which a drive shaft 12 is located. The drive shaft 12 is rotatably supported in the housing 10 via two bearing points 14 and 16, spaced apart from one another in the direction of the pivot axis 13 of the drive shaft 12. The bearing points 14, 16 may be located in different parts of the housing 10. In the region of the bearing points 14, 16, the housing 10 has a bore 18, 20, respectively, in which the drive shaft 12 is supported, via a respective bearing bush 22, 24.

[0012] In a region located between the two bearing points 14, 16, the drive shaft 12 has an eccentric portion 26, on which a transmission element 28 in the form of a polygonal ring is rotatably supported via a bearing point 30. The high-pressure pump 100 has at least one and preferably a plurality of pump elements 32 located in the housing 10, each with a respective pump piston 34 that is driven by the transmission element 28 in a reciprocating motion in a direction at least approximately radial to the pivot axis 13 of the drive shaft 12. The pump piston 34 is guided tightly displaceably in a cylinder bore 36 in the housing 10, or in an insert

in the housing 10, and with its face end facing away from the transmission element 28, it defines a pump work chamber 38 in the cylinder bore 36. Via a fuel inlet conduit 40 extending in the housing 10, the pump work chamber 38 has a communication with the feed pump 140. An inlet valve 42, which opens into the pump work chamber 38 and has a spring-loaded valve member 43, is located at the orifice of the fuel inlet conduit 40 into the pump work chamber 38. The pump work chamber 38 furthermore has a communication with the reservoir 110, via a fuel outlet conduit 44 extending in the housing 10. An outlet valve 46, opening out from the pump work chamber 38, is located at the orifice of the fuel outlet conduit 44 in the pump work chamber 38 and likewise has a spring-loaded valve member 47.

[0013] The pump piston 34 is kept with its piston base 50 in contact with the transmission element 28 by means of a prestressed spring 48. Upon the rotary motion of the drive shaft 12, the transmission element 28 is not moved with the drive shaft, but because of the eccentric portion 26, it executes a motion perpendicular to the pivot axis 13 of the drive shaft 12, which brings about the reciprocating motion of the pump piston 34. In the intake stroke of the pump piston 34, in which the pump piston moves radially inward, the pump work chamber 38 is filled with fuel through the fuel inlet conduit 40 while the inlet valve 42 is open and the outlet valve 46 is closed. In the pumping stroke of the pump piston 34, in which the pump piston moves radially outward, fuel is pumped at high pressure by the pump piston 34 through the fuel outlet conduit 44 to the reservoir 110, with the outlet valve 46 open and the inlet valve 42 closed.

[0014] The lubrication connection 170, originating at the feed pump 140, extends in the housing 10 in a conduit 52 that discharges at the outer jacket of the drive shaft 12. In the drive shaft 12, a conduit system is embodied, into which the conduit 52 discharges and through which fuel is carried under pressure to the bearing point 30 of the transmission element 28 on the eccentric portion 26 of the drive shaft 12, where the fuel emerges from the conduit system and lubricates the bearing point 30. The conduit system in the drive shaft 12

has a first conduit portion 54, which extends for instance at least approximately radially to the pivot axis 13 of the drive shaft 12 and is embodied as a bore, made from the outer jacket of the drive shaft 12 into the drive shaft and extending approximately to the middle of the drive shaft 12. The first conduit portion 54 discharges at the outer jacket of the drive shaft 12 in a plane in which the orifice of the conduit 52 in the housing 10 is also located. The first conduit portion 54 is adjoined by a second conduit portion 55, which extends in the direction of the pivot axis 13 of the drive shaft 12, for instance coaxially to the pivot axis 13. The second conduit portion 55 is embodied as a longitudinal bore, in particular in the form of a blind bore, made from one face end of the drive shaft 12 into the drive shaft. The second conduit portion 55 is closed, toward the face end of the drive shaft 12, by means of a closure element 56 inserted into the drive shaft. The second conduit portion 55 is adjoined by a third conduit portion 57, which extends for instance at least approximately radially to the pivot axis 13 of the drive shaft 12 and is embodied as a bore made into the drive shaft 12 from its outer jacket and which extends approximately to the middle of the drive shaft 12 and discharges into the second conduit portion 55. The third conduit portion 57 discharges at the outer jacket of the eccentric portion 26 of the drive shaft 12, preferably at least approximately in the middle of the bearing point 30 of the transmission element 28. Fuel pumped by the feed pump 140 travels via the lubrication connection 170, the conduit 52, and the conduit system 54, 55, 57 in the drive shaft 12 to reach the bearing point 30 of the transmission element 28 on the eccentric portion 26 of the drive shaft 12, where it emerges in order to lubricate it.

[0015] It may be provided that the transmission element 28 is supported directly on the eccentric portion 26. Alternatively, it may be provided that the transmission element 28 is supported on the eccentric portion 26 via a bearing bush 58. The bearing bush 58 may be embodied in one piece, as shown in Fig. 3, or in two parts, as shown in Fig. 2. The bearing bush 58 is split into two parts, located side by side in the direction of the pivot axis 13 of the drive shaft 12, and between which parts there is a gap 59. The gap 59 is preferably located in a plane in which the third conduit portion 57 discharges at the outer jacket of the eccentric

portion 26. The lubrication of the bearing point 30 is improved further by the split bearing bush 58, because the fuel emerging from the third conduit portion 57 can be distributed better in the bearing point 30.

[0016] In addition to the bearing point 30 of the transmission element 28 on the eccentric portion 26, one or both bearing points 14, 16 of the drive shaft 30 in the housing 10 can also be lubricated through the conduit system in the drive shaft 12. The second conduit portion 55 continues in the direction of the pivot axis 13 of the drive shaft 12 as far as the bearing point 16, where a fourth conduit portion 60 adjoins it. The fourth conduit portion 60 extends for instance at least approximately radially to the pivot axis 13 of the drive shaft 12 and is embodied as a bore that is made into the drive shaft 12 from its outer jacket and that extends approximately to the middle of the drive shaft 12 and discharges into the second conduit portion 55. The fourth conduit portion 60 discharges at the outer jacket of the drive shaft 12, preferably at least approximately in the middle of the bearing point 16 of the drive shaft 12. The bearing bush 24 of the bearing point 16 may be in one piece or, as described above for the bearing bush 58, in two parts, with a gap 25 between the parts.

[0017] In addition, the bearing point 14 of the drive shaft 12 in the housing 10 can also be lubricated by the fuel pumped by the feed pump 140 via the lubrication connection 170 and the conduit 52. The first conduit portion 54 then discharges at the outer jacket of the drive shaft 12 in the region of the bearing point 14, preferably at least approximately in the middle of the bearing point 14. However, assurance must be provided that fuel from the conduit 52 can reach the first conduit portion 54 through the bearing shell 22 of the bearing point 14. To that end, the bearing shell 22 may be divided into two parts, as shown in Fig. 2 and as explained above for the bearing shell 58; the gap 23 between the parts of the bearing shell 22 is located in the plane of the orifice of the first conduit portion 54 at the outer jacket of the drive shaft 12.

[0018] In Fig. 4, a modified version of the bearing shell 22 is shown, in which the bearing shell is in one piece. In its inner jacket, the bearing shell 22 has an annular groove 62, which is formed by a plunge cut. The annular groove 62 is located at least approximately in the same plane as the orifice of the conduit 52 at the outer jacket of the bearing bush 22 and the orifice of the first conduit portion 54 at the inner jacket of the bearing bush 22. The bearing bush 22 furthermore has at least one bore 64, which connects the annular groove 62 to the outer jacket of the bearing bush 22. From the conduit 52, fuel can flow through the bore 64 and the annular groove 62 into the first conduit portion 54 of the drive shaft 12.

[0019] In the region of each of the bearing points 14, 16 and 30, respective outlet conduits 66 may be provided in the housing 10, through which conduits fuel can flow away again from the bearing points.